8. Hazard Mitigation Measures and Benefits

8.1 Introduction

A primary objective of this study is to identify the most critical lifelines and develop a prioritized series of steps for reduction of lifeline seismic vulnerability, based on overall benefits. In this chapter we identify the most critical lifelines and provide a relative ranking of the criticality of these different lifelines in terms of the estimated impact of damage and economic disruption. Also included are recommended key measures for reducing the earthquake vulnerability of these lifeline systems, and results from analytical computations to illustrate the reduction in losses if such hazard mitigation strategies are employed.

8.2 Identification of Critical Lifelines

Based on the combined direct and indirect economic losses presented in Chapter 7 and with due consideration of the assumptions and limitations expressed throughout this report, we offer the following relative ranking of the criticality of different lifelines in terms of the estimated impact of damage and disruption:

Rank	Lifeline	Event/Location
1.	Electric System	New Madrid (M=8.0)
		Hayward
		Cape Ann, Charleston, Fort Tejon
2.	Highways	New Madrid (M=8.0)
		Fort Tejon
		Hayward, New Madrid (M=7.0)
3.	Water System*	Fort Tejon
4.	Ports	Charleston
5.	Crude Oil	Fort Tejon

*The ranking for the water system may be underestimated because critical components such as pumping stations and dams were not included in the study.

8.3 Measures for Reducing Vulnerability of Lifeline Systems

The seismic vulnerability of lifeline systems, from the point of view of fulfilling function, can be reduced through three primary approaches:

1. **Damage reduction measures.** In this approach reliability of function is enhanced by reducing damage. This approach may take the form of :

   - Strengthening a building, bracing equipment, or performing other corrective retrofit measures to mitigate shaking effects;
   - Densifying the soil beneath a structure, or placing a structure on piles, or using other techniques to mitigate hazardous geotechnical conditions, e.g., liquefaction potential,
   - Other component improvements, depending on the component and potential earthquake impacts, e.g., replacement of vulnerable systems/components with new systems/components that will provide improved seismic resistance.

2. **Provision for system redundancy.** In this approach, reliability of function is enhanced by providing additional and alternative links (e.g., new highways, pipelines, other transmission or distribution links). Because earthquake damage is fundamentally a random phenomena, addition of system links will tend to increase system reliability.

3. **Operational improvements.** In this approach reliability of function is enhanced by providing emergency response planning and the capability to rapidly and effectively repair damage, redirect functions, or otherwise mitigate earthquake damage impacts on system operations and thereby re-establish system function.

Of these measures, the most common are component strengthening/retrofit measures, which are discussed at length in Appendix B of this report. The proposed measures (Appendix B) include generic solutions, such as designing structures to meet current seismic design or retrofit standards of the local community, or anchoring equipment. In addition, there are numerous specific measures that relate to unique systems or components within each lifeline. Special attention should be directed to those systems and conditions that are of greatest concern, such as porcelain components in electric substations.

Following are recommended steps when implementing a program to reduce seismic hazards of existing lifelines:

1. Review existing descriptions of seismic performance and rehabilitation measures for the lifeline(s) of concern, i.e., familiarize yourself and your organization with the overall problem. Sources include Appendix B and Chapter 10 (References) of this report.

2. Conduct an investigation of the seismic vulnerability and impact of disruption for the lifeline(s) and region(s) of concern. Lifeline seismic evaluation methodologies and other potential resources for this purpose have been developed by the ASCE Technical Council for Lifeline Earthquake Engineering (see references, Chapter 10), the Applied Technology Council (ATC, in preparation) and others.

3. Focus first on the most vulnerable lifelines, components, and conditions (e.g., liquefaction or landslide potential). Vulnerable components include:

   For electric systems:
   - Substations
   - Power stations

   For water systems:
   - Pumping stations
   - Tanks and reservoirs
   - Treatment plants
   - Transmissions aqueducts

   For highway systems
   - Bridges
   - Tunnels
   - Roadbeds

   For water transportation systems:
   - Port/cargo handling equipment
   - Inland waterways

   For gas and liquid fuels:
   - Distribution storage tanks
   - Transmission pipelines
   - Compressor, metering and pressure reduction stations

4. Conduct cost-benefit studies to determine the most cost effective measures. We note that, in some cases, retrofit measures may not be very cost effective. In regions where the return period for large earthquakes is quite long, for example, replacement over the life cycle of the facility or component may be a reasonable approach.

5. Implement the selected hazard reduction measures.

8.4 Estimated Overall Benefits of Implementing Hazard Reduction Measures

In order to provide an indication of the overall benefit of implementing hazard mitigation measures, we have computed and compare estimated direct damage and indirect economic losses for the existing and an upgraded extended regional electric network, with specific focus on the most vulnerable component for this lifeline--substations. Estimated direct damage and indirect economic losses for the existing network are taken from Chapters 5 and 6, respectively. Estimated direct damage and indirect economic losses for the hypothetical upgraded network have been computed using the same techniques and data as used for the existing network, but seismic intensities have been shifted downward two units to reflect the improved performance of the upgraded system. While this is a rather simplistic approach, we believe the results reasonably indicate the extent of benefit provided by rehabilitation.

Direct Damage Comparisons. Percentages of substations in the existing and upgraded system in the various damage states are provided in Tables 8-1 and 8-2 respectively. With the exception of 1% of the upgraded substations in Missouri and Tennessee that would sustain major-to-destructive damage in the magnitude-8.0 New Madrid event, none of the substations

in other locations for this event or in other events would sustain damage this severe. In contrast, 43 percent of the transmission substations in Washington, 29 percent in Arkansas, 16 percent in South Carolina, 13 percent in California, 10 percent in Utah, 8 percent in Missouri, and 6 percent in Tennessee would sustain damage in this range in the various earthquake scenarios. Trends for lower damage states are similar, as are trends for transmission lines (not shown here).

Indirect Economic Loss Comparisons. Indirect economic losses resulting from damage to the existing and upgraded systems are provided in Tables 8-3 and 8-4. Table 8-3 includes data for all affected states, whereas Table 8-4 does not include data for states for which damage to the upgraded system was zero or insignificant. Data for the upgraded system are based on residual capacity plots provided in Appendix C (Figures C-185 through C-200).

By comparing the results in Tables 8-3 and 8-4, it is clear that indirect economic losses are substantially reduced through seismic upgrade measures. For example, the ratio of indirect economic loss to the retail trade sector resulting from damage to the existing system versus loss resulting from damage to the upgraded system ranges from 2.5 to 34 for the 7 events and 8 states considered in both analyses. A comparison of data for the other economic sectors shows similar trends.

Table 8-1 Damage Percent for Existing Electric Transmission Substations for Each Scenario Earthquake (Percent of Substations in State)

	NEW MADRID (M=8.0)							CHARLESTON (M=7.5)		
Total Number	*Illinois 108*	*Missouri 95*	*Arkansas 124*	*Tennessee 70*	*Kentucky 68*	*Indiana 89*	*Mississippi 93*	*South Carolina 100*	*North Carolina 76*	*Georgia 86*
Light Damage 1-10 %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Moderate 10-30 %	14%	8%	22%	16%	24%	2%	63%	43%	20%	33%
Heavy 30-60 %	0%	0%	10%	9%	7%	0%	8%	14%	0%	3%
Major to Destructive 60-100 %	0%	8%	29%	6%	1%	0%	10%	16%	1%	2%

	CAPE ANN (M=7.0)					WASATCH FRONT (M=7.5)
Total Number	*Massachusetts 153*	*Connecticut 69*	*Delaware 3*	*Rhode Island 22*	*New Hampshire 22*	*Utah 10*
Light Damage 1-10 %	0%	0%	0%	0%	0%	0%
Moderate 10-30 %	82%	42%	33%	100%	45%	30%
Heavy 30-60 %	0%	0%	0%	0%	0%	20%
Major to Destructive 60-100 %	5%	0%	0%	0%	0%	10%

	HAYWARD (M7.5)	FORT TEJON (M=8.0)	PUGET SOUND (M=7.5)	NEW MADRID (M=7.0)					
Total Number	*California 205*	*California 205*	*Washington 155*	*Illinois 108*	*Missouri 95*	*Arkansas 124*	*Tennessee 70*	*Kentucky 68*	*Mississippi 93*
Light Damage 1-10 %	8%	11%	0%	0%	0%	0%	0%	0%	0%
Moderate 10-30 %	13%	6%	12%	0%	2%	21%	16%	16%	14%
Heavy 30-60 %	14%	< 1%	3%	0%	0%	16%	0%	0%	2%
Major to Destructive 60-100 %	13%	12%	43%	0%	6%	6%	3%	0%	0%

Table 8-2 Damage Percent for Upgraded Electric Transmission Substations for Each Scenario Earthquake (Percent of Substations in State)

	NEW MADRID (M=8.0)							CHARLESTON (M=7.5)		
Total Number	*Illinois 108*	*Missouri 95*	*Arkansas 124*	*Tennessee 70*	*Kentucky 68*	*Indiana 89*	*Mississippi 93*	*South Carolina 100*	*North Carolina 76*	*Georgia 86*
Light 0-10 %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Moderate 10-30 %	0%	0%	21%	11%	9%	0%	10%	24%	1%	1%
Heavy 30-60 %	0%	7%	8%	1%	0%	0%	0%	6%	0%	1%
Major to Destructive 60-100 %	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%

	CAPE ANN (M=7.0)					WASATCH FRONT (M=7.5)
Total Number	*Massachusetts 153*	*Connecticut 69*	*Delaware 3*	*Rhode Island 22*	*New Hampshire 22*	*Utah 10*
Light 0-10 %	0%	0%	0%	0%	0%	0%
Moderate 10-30 %	1%	0%	0%	0%	0%	30%
Heavy 30-60 %	5%	0%	0%	0%	0%	0%
Major to Destructive 60-100 %	0%	0%	0%	0%	0%	0%

	HAYWARD (M7.5)	FORT TEJON (M=8.0)	PUGET SOUND (M=7.5)	NEW MADRID (M=7.0)					
Total Number	*California 205*	*California 205*	*Washington 155*	*Illinois 108*	*Missouri 95*	*Arkansas 124*	*Tennessee 70*	*Kentucky 68*	*Mississippi 93*
Light 0-10 %	12%	6%	0%	0%	0%	0%	0%	0%	0%
Moderate 10-30 %	21%	11%	21%	0%	3%	6%	1%	0%	0%
Heavy 30-60 %	0%	1%	22%	0%	3%	0%	1%	0%	0%
Major to Destructive 60-100 %	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 8-3 Indirect Economic Loss Due to Damage to the Existing Electric System (Percent Monthly GNP)

			NEW MADRID (M=8.0)						CHARLESTON			CAPE ANN		
		U.S. Econ. Value Added (Percent)	Illinois	Missouri	Arkansas	Tennessee	Kentucky	Mississippi	South Carolina	North Carolina	Georgia	Massachusetts	Connecticut	Delaware
1	Livestock	0.45%	3.95%	6.58%	32.89%	13.16%	13.16%	44.74%	46.05%	7.89%	18.42%	44.74%	15.79%	10.53%
2	Agr. Prod.	1.06%	3.95%	6.58%	32.89%	13.16%	13.16%	44.74%	46.05%	7.89%	18.42%	44.74%	15.79%	10.53%
3	AgServ For. Fish	0.11%	3.95%	6.58%	32.89%	13.16%	13.16%	44.74%	46.05%	7.89%	18.42%	44.74%	15.79%	10.53%
4	Mining	3.89%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
5	Construction	5.52%	3.16%	5.26%	26.32%	10.53%	10.53%	35.79%	36.84%	6.32%	14.74%	35.79%	12.63%	8.42%
6	Food Tobacco	2.41%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
7	Textile Goods	0.37%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
8	Misc Text. Prod.	0.73%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
9	Lumber & Wood	0.52%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
10	Furniture	0.34%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
11	Pulp & Paper	0.87%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
12	Print & Publish	1.31%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
13	Chemical & Drugs	1.40%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
14	Petrol. Refining	0.96%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
15	Rubber & Plastic	1.03%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
16	Leather Prods.	0.12%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
17	Glass Stone Clay	0.62%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
18	Prim. Metal Prod.	1.04%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
19	Fab. Metal Prod.	1.64%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
20	Mach. Exc. Elec.	1.56%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
21	Elec. & Electron	2.52%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
22	Transport Eq.	2.62%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
23	Instruments	0.68%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
24	Misc. Manufact.	0.69%	7.89%	13.16%	65.79%	26.32%	26.32%	89.47%	92.11%	15.79%	36.84%	89.47%	31.58%	21.05%
25	Transp & Whse.	3.46%	2.37%	3.95%	19.74%	7.89%	7.89%	26.84%	27.63%	4.74%	11.05%	26.84%	9.47%	6.32%
26	Utilities	5.89%	6.32%	10.53%	52.63%	21.05%	21.05%	71.58%	73.68%	12.63%	29.47%	71.58%	25.26%	16.84%
27	Wholesale Trade	5.63%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
28	Retail Trade	5.63%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
29	F.I.R.E.	16.64%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
30	Pers./Prof Serv.	8.03%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
31	Eating Drinking	2.12%	6.32%	10.53%	52.63%	21.05%	21.05%	71.58%	73.68%	12.63%	29.47%	71.58%	25.26%	16.84%
32	Auto Serv.	1.09%	7.11%	11.84%	59.21%	23.68%	23.68%	80.53%	82.89%	14.21%	33.16%	80.53%	28.42%	18.95%
33	Amuse & Rec.	0.70%	6.32%	10.53%	52.63%	21.05%	21.05%	71.58%	73.68%	12.63%	29.47%	71.58%	25.26%	16.84%
34	Health Ed. Soc.	6.30%	6.32%	10.53%	52.63%	21.05%	21.05%	71.58%	73.68%	12.63%	29.47%	71.58%	25.26%	16.84%
35	Govt & Govt Ind.	11.79%	4.74%	7.89%	39.47%	15.79%	15.79%	53.68%	55.26%	9.47%	22.11%	53.68%	18.95%	12.63%
36	Households	0.25%	6.32%	10.53%	52.63%	21.05%	21.05%	71.58%	73.68%	12.63%	29.47%	71.58%	25.26%	16.84%

Table 8-3 Indirect Economic Loss Due to Damage to the Existing Electric System (Percent Monthly GNP) (Continued)

		U.S. Econ. Value Added (Percent)	CAPE ANN		WASATCH	CALIFORNIA		PUGET SOUND	NEW MADRID (M=7.0)			
			Rhode Island	New Hampshire	Utah	Hayward	Fort Tejon	Washington	Arkansas	Tennessee	Kentucky	Mississippi
1	Livestock	0.45%	42.11%	14.47%	35.53%	23.68%	13.16%	47.37%	23.68%	7.89%	3.95%	3.95%
2	Agr. Prod.	1.06%	42.11%	14.47%	35.53%	23.68%	13.16%	47.37%	23.68%	7.89%	3.95%	3.95%
3	AgServ For. Fish	0.11%	42.11%	14.47%	35.53%	23.68%	13.16%	47.37%	23.68%	7.89%	3.95%	3.95%
4	Mining	3.89%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
5	Construction	5.52%	33.68%	11.58%	28.42%	18.95%	10.53%	37.89%	18.95%	6.32%	3.16%	3.16%
6	Food Tobacco	2.41%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
7	Textile Goods	0.37%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
8	Misc Text. Prod.	0.73%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
9	Lumber & Wood	0.52%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
10	Furniture	0.34%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
11	Pulp & Paper	0.87%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
12	Print & Publish	1.31%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
13	Chemical & Drugs	1.40%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
14	Petrol. Refining	0.96%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
15	Rubber & Plastic	1.03%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
16	Leather Prods.	0.12%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
17	Glass Stone Clay	0.62%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
18	Prim. Metal Prod.	1.04%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
19	Fab. Metal Prod.	1.64%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
20	Mach. Exc. Elec.	1.56%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
21	Elec. & Electron	2.52%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
22	Transport Eq.	2.62%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
23	Instruments	0.68%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
24	Misc. Manufact.	0.69%	84.21%	28.95%	71.05%	47.37%	26.32%	94.74%	47.37%	15.79%	7.89%	7.89%
25	Transp & Whse.	3.46%	25.26%	8.68%	21.32%	14.21%	7.89%	28.42%	14.21%	4.74%	2.37%	2.37%
26	Utilities	5.89%	67.37%	23.16%	56.84%	37.89%	21.05%	75.79%	37.89%	12.63%	6.32%	6.32%
27	Wholesale Trade	5.63%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
28	Retail Trade	5.63%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
29	F.I.R.E.	16.64%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
30	Pers./Prof Serv.	8.03%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
31	Eating Drinking	2.12%	67.37%	23.16%	56.84%	37.89%	21.05%	75.79%	37.89%	12.63%	6.32%	6.32%
32	Auto Serv.	1.09%	75.79%	26.05%	63.95%	42.63%	23.68%	85.26%	42.63%	14.21%	7.11%	7.11%
33	Amuse & Rec.	0.70%	67.37%	23.16%	56.84%	37.89%	21.05%	75.79%	37.89%	12.63%	6.32%	6.32%
34	Health Ed. Soc.	6.30%	67.37%	23.16%	56.84%	37.89%	21.05%	75.79%	37.89%	12.63%	6.32%	6.32%
35	Govt & Govt Ind.	11.79%	50.53%	17.37%	42.63%	28.42%	15.79%	56.84%	28.42%	9.47%	4.74%	4.74%
36	Households	0.25%	67.37%	23.16%	56.84%	37.89%	21.05%	75.79%	37.89%	12.63%	6.32%	6.32%

Table 8-4 Indirect Economic Loss Due to Damage to the Upgraded Electric System (Percent Monthly GNP)

			NEW MADRID (M=8.0)		CHARLESTON	CAPE ANN	WASATCH	HAYWARD	FT. TEJON	WASHINGTON
		U.S. Econ. Value-Added (Percent)	Arkansas	Tennessee	S Carolina	Massachusetts	Utah	California	California	Washington
1	Livestock	0.45%	13.16%	5.26%	15.79%	1.32%	10.53%	5.26%	2.63%	18.42%
2	Agr. Prod.	1.06%	13.16%	5.26%	15.79%	1.32%	10.53%	5.26%	2.63%	18.42%
3	AgServ For. Fish	0.11%	13.16%	5.26%	15.79%	1.32%	10.53%	5.26%	2.63%	18.42%
4	Mining	3.89%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
5	Construction	5.52%	10.53%	4.21%	12.63%	1.05%	8.42%	4.21%	2.11%	14.74%
6	Food Tobacco	2.41%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
7	Textile Goods	0.37%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
8	Misc Text. Prod.	0.73%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
9	Lumber & Wood	0.52%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
10	Furniture	0.34%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
11	Pulp & Paper	0.87%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
12	Print & Publish	1.31%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
13	Chemical & Drugs	1.40%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
14	Petrol. Refining	0.96%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
15	Rubber & Plastic	1.03%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
16	Leather Prods.	0.12%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
17	Glass Stone Clay	0.62%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
18	Prim. Metal Prod.	1.04%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
19	Fab. Metal Prod.	1.64%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
20	Mach. Exc. Elec.	1.56%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
21	Elec. & Electron	2.52%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
22	Transport Eq.	2.62%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
23	Instruments	0.68%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
24	Misc. Manufact.	0.69%	26.32%	10.53%	31.58%	2.63%	21.05%	10.53%	5.26%	36.84%
25	Transp & Whse.	3.46%	7.89%	3.16%	9.47%	0.79%	6.32%	3.16%	1.58%	11.05%
26	Utilities	5.89%	21.05%	8.42%	25.26%	2.11%	16.84%	8.42%	4.21%	29.47%
27	Wholesale Trade	5.63%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
28	Retail Trade	5.63%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
29	F.I.R.E.	16.64%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
30	Pers./Prof Serv.	8.03%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
31	Eating Drinking	2.12%	21.05%	8.42%	25.26%	2.11%	16.84%	8.42%	4.21%	29.47%
32	Auto Serv.	1.09%	23.68%	9.47%	28.42%	2.37%	18.95%	9.47%	4.74%	33.16%
33	Amuse & Rec.	0.70%	21.05%	8.42%	25.26%	2.11%	16.84%	8.42%	4.21%	29.47%
34	Health Ed. Soc.	6.30%	21.05%	8.42%	25.26%	2.11%	16.84%	8.42%	4.21%	29.47%
35	Govt & Govt Ind.	11.79%	15.79%	6.32%	18.95%	1.58%	12.63%	6.32%	3.16%	22.11%
36	Households	0.25%	21.05%	8.42%	25.26%	2.11%	16.84%	8.42%	4.21%	29.47%